03-1901 PCT

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FORM PTO-1390 (REV 10-94)

U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

DOCKET #: 5029-30PUS

INTERNATIONAL APPLICATION NO	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED	U.S. APPLICATION NO. (If known, see 37 CFR 1.5)
PCT/EP99/06564	September 07, 1999	September 16, 1998	09/787471

TITLE OF INVENTION

Device and Method for Injection-Compression Molding

APPLICANT(S) FOR DO/EO/US

Dieter KELLER

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [x] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371
3. [x] This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. [x] A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. [x] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [x] is transmitted herewith (required only if not transmitted by the International Bureau).
   b. [] has been transmitted by the International Bureau.
   c. [] is not required, as the application was filed in the United States Receiving Office (RO/US)
6. [x] A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. [x] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [] are transmitted herewith (required only if not transmitted by the International Bureau).
   b. [] have been transmitted by the International Bureau.
   c. [] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [x] have not been made and will not be made.
8. [] A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. [x] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [] A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. Below concern other document(s) or information included:

11. [x] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [x] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [x] A **FIRST** preliminary amendment.
    [] A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. [] A substitute specification.
15. [] A change of power of attorney and/or address letter.
16. [x] Other items or information *(specify)*: PCT Publication Sheet, Int'l Preliminary Examination Report, Int'l Search Report, Letter with Proposed Drawing Changes

U.S. APPLICATION NO. (If known, see 37 C.F.R. 1.5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
09/787471	PCT/EP99/06564	5029-30PUS

17.[x]The following fees are submitted:

Basic National Fee (37 CFR 1.492(a)(1)-(5)):		
Search Report has been prepared by the EPO or JPO **$860.00**		
International preliminary examination fee paid to USPTO (37 CFR 1.482)..... **$690.00**		
No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2))..... **$710.00**		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$1000.00**		
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) **$100.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$	860.00
Surcharge of **$130.00** for furnishing the oath or declaration later than [] 20 [] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$	

Claims	Number Filed	Number Extra	Rate		
Total Claims	16 - 20 =		x **$18.00**	$	
Independent Claims	2 - 3 =		x **$80.00**	$	
Multiple dependent claim(s) (if applicable)			+ **$270.00**	$	
TOTAL OF ABOVE CALCULATIONS =				$	860.00
Reduction of ½ for filing by small entity, if applicable.				$	
SUBTOTAL =				$	860.00
Processing fee of **$130.00** for furnishing the English translation later than [] 20 [] 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
TOTAL NATIONAL FEE =				$	860.00
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by the appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$	40.00
TOTAL FEES ENCLOSED					$900.00
Amount to be refunded:					$
charged:					$

[x]Two checks in the amounts of $ 860 and $ 40 to cover the above fees are enclosed.

[] Please charge my Deposit Account No. 03-2412 in the amount of $____ to cover the above fees. A duplicate copy of this sheet is enclosed.

[x]The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 03-2412. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO
Thomas C. Pontani
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551 Fifth Avenue, Suite 1210
New York, New York 10176

Klaus P. Stoffel
Registration Number: 31,668
Tel: (212) 687-2770

By Express Mail # EL645965275US · March 16, 2001

Attorney Docket # 5029-30PUS

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re National Phase PCT Application of

Dieter KELLER

International Appln. No.: PCT/EP99/06564

International Filing Date: September 07, 1999

For: Device and Method for Injection-Compression Molding

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231
BOX PCT

S I R:

Prior to examination of the above-identified application please amend the application as follows:

In the Specification:

On page 1, between lines 1 and 2, delete "Description" and insert the following new headings:

BACKGROUND OF THE INVENTION

1. Field of the Invention

Amend the paragraph starting on line 5 as follows:

The invention relates to an apparatus and a method for injection-compression molding with a mold and a drive moving the mold. The apparatus and method are used for producing molded parts, in particular plastic molded parts.

2. Description of the prior art

Page 2, after line 35 insert

SUMMARY OF THE INVENTION

Page 3, please amend the paragraph starting on line 3, as follows:

According to the invention, the object of the present invention is met by an apparatus for injection-compression molding of a molded part having a mold with first and second plates in which opposing end faces of the plates define a first negative form of the molded part to be formed and a threaded screw drive assembly is operatively connected to one of the first and second plates for positioning the one of the first and second plates. The threaded screw drive assembly includes a threaded screw drive, a gear mechanism, and a controlled drive operatively connected to the threaded screw drive via the gear mechanism for positioning the one of the first and second plates.

The object of the present invention is also met by a method for injection-compression molding a molded part including the steps of moving a plate of the mod for compressing the molding composition via a threaded screw drive assembly and controlling the movement via one of a movement program and in dependence on a process parameter.

Page 6 after line 37 insert

BRIEF DESCRIPTION OF THE DRAWINGS

Amend the paragraph starting on line 38 of page 6, as follows:

The drawing is longitudinal sectional view showing a mold with a threaded screw drive and a fixedly arranged spindle nut according to an embodiment of the present invention.

Amend the paragraph starting on line 4 of page 7, as follows:

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The apparatus for injection-compression molding comprises a mold 1which has two plates 2, 2'. Machined in the plate 2 on opposing end faces 3, 3' there is a first negative form 4 of the molded part to be produced. Arranged in the plate 2' is a mold insert 5, in which there is machined a second negative form 4' on its side facing the plate 2. The opposite side of the mold insert 5 is connected to a threaded spindle 6 of a threaded screw drive assembly 7. The threaded spindle 6 is mounted in the plate 2' and another plate 9 by antifriction guideways 8 in such a way that it is freely movable. A spindle nut 10 is arranged rotatably in a further plate 11 of the mold 1 for driving the threaded spindle 6. The spindle nut 10 is driven via a planetary gear mechanism 12 by an electric motor 13. The rotational speed and direction of rotation of the electric motor 13 are prescribed by a control 14.

Further threaded screw drive assemblies 7a and 7b may be operatively connected to plates 2 and 2' as shown in the drawing for controlling the positions of plates 2 and 2'. Furthermore, a threaded screw driver 7c is also connected to plate 2 such that accurate replication may be achieved for large molded parts. The threaded screw drive assembly 7c includes a thread spindle 6c and a spindle nut 10c connected to plate 2. Accordingly, the plate 2 moves with the spindle nut 10c as the spindle nut traverses the threaded spindle 6c. In any of the threaded screw drive assemblies 7, 7a, 7b, 7c, either the threaded spindle or the spindle nut may be connected to the part to be moved, i.e., plate 2, plate 2', or mold insert 5.

For producing a molded part, the plate 2 moves toward the plate 2', so that the mold 1 is closed, with the mold insert 5 entering the first negative form 4 of the plate 2. This position of the mold insert 5 corresponds to the opening gap. A precisely defined amount of molding composition is then injected into the cavity 16 formed by the first negative form 4 and the mold insert 5 via a hot-runner nozzle 15 arranged in the plate 2. In order that the molding composition does not cool down excessively as a result of thermal conduction, heating elements 17 for controlling the temperature of the plates 2, 2' are arranged in the plates 2, 2'. After the injection, a gate 18 in the hot-runner nozzle 15 is closed by a gate needle 19. After that, the threaded spindle 6 is moved to the right by means of the spindle nut 10 to the extent that the mold insert 5 is positioned at a defined distance - the compression gap - from the first negative form 4 of the plate 2. With this reduction in volume of the cavity 16, the injected molding composition is subjected to pressure, so that the molding composition completely fills the cavity 16. The positioning of the plate 2 in this case does not take place uniformly, but is

controlled by the control 14. The power consumption of the electric motor 13 is used as a control variable. For this purpose, the power consumption is measured. With increasing internal mold pressure, the power consumption of the electric motor 13 increases. If the measured value is less than the prescribed value, the plate 2 is moved by 1 μm in the direction of the plate 2'. After that, the power consumption is measured again and compared with the setpoint value. As long as the measured value lies below the setpoint value, the plate 2 is moved step by step. If the measured value is greater than the setpoint value, the electric motor 13 is stopped. After a certain time, the plate 2 is moved again in the direction of the plate 2' and as this happens the power consumption is measured again. These steps are repeated until the molding composition has solidified. After solidifying of the molding composition, the mold 1 is opened at its mold parting plane between the plates 2, 2' and the finished molded part is ejected by an ejector 20.

In the Claims:

Please delete claims 1-16 and add new claims 17-32

17. An apparatus for injection-compression molding of a molded part, comprising:

a mold including first and second plates having opposing end faces defining a mold parting plane for opening and closing the mold, wherein said opposing end faces have a first negative form of the molded part to be produced and a gate through which a molding composition is introducible; and

a first threaded screw drive assembly connected to one of said first and second plates including a threaded screw drive, a gear mechanism connected to said threaded screw drive, and a controlled drive operatively connected to said threaded screw drive via said gear mechanism for positioning said one of said first and second plates.

18. The apparatus of claim 17, wherein said first threaded screw drive assembly comprises a plurality of screw drive assemblies connected to said one of said first and second plates.

19. The apparatus of claim 17, further comprising a second threaded drive screw assembly, wherein said first threaded screw drive assembly is operatively connected for positioning said first plate and said second threaded screw drive assembly is operatively connected for positioning said second plate.

20. The apparatus of claim 17, wherein said threaded screw drive comprises a spindle nut connected to said one of said first and second plates.

21. The apparatus of claim 17, wherein said threaded screw drive comprises a threaded spindle connected to said one of said first and second plates.

22. The apparatus of claim 17, further comprising a mold insert having a second negative form of the molded part to be produced and arranged in said first and second plates and a second threaded screw drive assembly connected for positioning said mold insert.

23. The apparatus of claim 17, further comprising a die arranged in one of said first and second plates having said first negative form, wherein said threaded screw drive is connected to said die.

24. The apparatus of claim 17, further comprising heating elements arranged in said first and second plates.

25. The apparatus of claim 17, wherein said gear mechanism is a planetary gear mechanism.

26. The apparatus of claim 17, further comprising at least one ejector arranged in said threaded screw drive assembly.

27. A method for injection-compression molding a molded part, comprising the steps of:

a. injecting a molding composition into a cavity of the mold defined at least partially by a plate having a negative form of the molded part to be produced;

b. moving the plate of the mold having a negative form of the molded part to be produced for compressing the molding composition via a threaded screw drive assembly; and

c. controlling the movement of the plate in said step b. by one of a movement program and in dependence on a process parameter.

28. The method of claim 27, wherein said step c. comprises controlling the movement of the plate in dependence on a pressure present in the mold.

29. The method of claim 27, wherein said step c. comprises controlling the movement of the plate in dependence on a power consumption of a motor driving the threaded screw drive assembly.

30. The method of claim 27, wherein said step c. comprises controlling the movement of the plate in dependence on a force on the threaded screw drive.

31. The method of claim 27, wherein said step b. comprises moving the plate via a step by step motion.

32. The method of claim 31, wherein said step b. comprises moving the plate in a step by step motion comprising steps of less than 1 micrometer.

IN THE ABSTRACT:

Please amend the Abstract as follows:

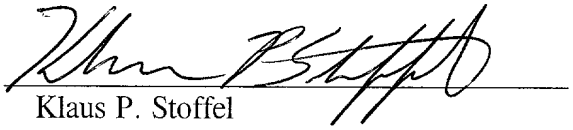
An apparatus for injection-compression molding comprises a mold with plates which have the negative form of the molded part to be produced. The plates are connected to a threaded screw drive which is driven via a gear mechanism by a controlled drive. The positioning in this case takes place on the basis of a prescribed program or in dependence on at least one process parameter. The apparatus and the method make possible the production of molded parts, in particular plastic molded parts, with a high accuracy of replication.

REMARKS

This preliminary amendment is presented to place the application in proper form for examination and to eliminate multiple dependency from the present claims. No new matter has been added. Early examination and favorable consideration of the above-identified application is earnestly solicited.

Any additional fees or charges required at this time in connection with the application may be charged to our Patent and Trademark Office Deposit Account No. 03-2412.

Respectfully submitted,
COHEN, PONTANI, LIEBERMAN & PAVANE

By: 

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16 March 2001

Attorney Docket # 5029-30PUS

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re National Phase PCT Application of

Dieter KELLER et al.

International Appln. No.: PCT/EP99/06564

International Filing Date: September 07, 1999

For: Device and Method for Injection-Compression Molding

LETTER WITH PROPOSED DRAWING CHANGES

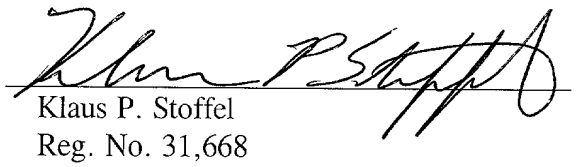
Assistant Commissioner for Patents
Washington, D.C. 20231
BOX PCT

S I R:

Please admit the attached proposed correction to the Figure. The attached copies of the Figure show the proposed corrections in red. The proposed corrections show additional threaded screw device assemblies 7a, 7b, 7c that are referenced in the specification in addition to the threaded screw device assembly 7 that is already shown.

It is believed that no additional fees or charges are required at this time in connection with the above-identified application; however, if any fees or charges are required at this time in connection with the application, they may be charged to our Patent and Trademark Office Deposit Account No. 03-2412.

Respectfully submitted,
COHEN, PONTANI, LIEBERMAN & PAVANE

By: 

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16 March 2001

Enclosures: Proposed drawings

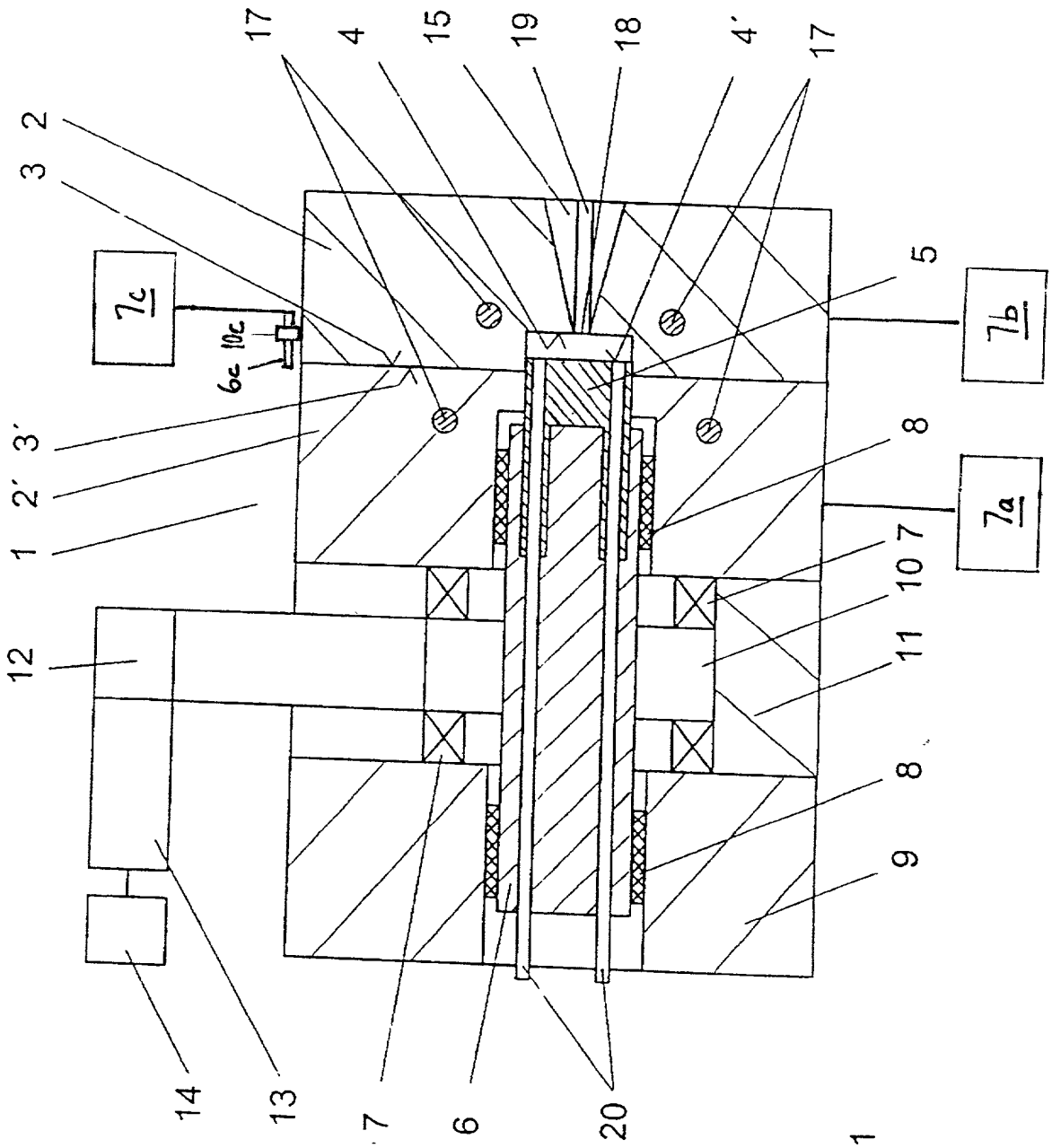

Fig. 1

MARKED UP VERSIONS OF REPLACEMENT PARAGRAPHS

On page 1, between lines 1 and 2, delete "Description" and insert the following new headings:

--BACKGROUND OF THE INVENTION

1. Field of the Invention--;

Amend the paragraph starting on line 5 as follows:

-- The invention [concerns] relates to an apparatus and a method for injection-compression molding with a mold and a drive moving the mold. The apparatus and method are used for producing molded parts, in particular plastic molded parts.

2. Description of the prior art--;

Page 2, after line 35 insert

--SUMMARY OF THE INVENTION

Page 3, please amend the paragraph starting on line 3, as follows:

According to the invention, the object [is achieved by the features of Patent Claims 1 and 11. Advantageous configurations are described in Claims 2 to 10 and 12 to 16.]of the present invention is met by an apparatus for injection-compression molding of a molded part having a mold with first and second plates in which opposing end faces of the plates define a first negative form of the molded part to be formed and a threaded screw drive assembly is operatively connected to one of the first and second plates for positioning the one of the first and second plates. The threaded screw drive assembly includes a threaded screw drive, a gear mechanism, and a controlled drive operatively connected to the threaded screw drive via the gear mechanism for positioning the one of the first and second plates.

The object of the present invention is also met by a method for injection-compression molding a molded part including the steps of moving a plate of the mod for compressing the molding composition via a threaded screw drive assembly and controlling the movement via one of a movement program and in dependence on a process parameter.;

Page 6 after line 37 insert

--BRIEF DESCRIPTION OF THE DRAWINGS

Amend the paragraph starting on line 38 of page 6, as follows:

[The invention allows numerous embodiments. To illustrate the basic principle, one of these is described below.] The [associated figure shows] drawing is longitudinal sectional view showing a mold with a threaded screw drive[,] [with] and a fixedly arranged spindle nut according to an embodiment of the present invention.

Amend the paragraph starting on line 4 of page 7, as follows:

--DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The apparatus for injection-compression molding comprises a mold 1[,] which has two plates 2, 2'. Machined in the plate 2 on [the] opposing end faces 3, 3' there is a first negative form 4 of the molded part to be produced. Arranged in the plate 2' is a mold insert 5, in which there is machined a second negative form 4' on its side facing the plate 2. [On its] The opposite side[,] of the mold insert 5 is connected to a threaded spindle 6 of a threaded screw drive assembly 7. The threaded spindle 6 is mounted in the [plates] plate 2' and another plate 9 by [means of] antifriction guideways 8 in such a way that it is freely movable. A spindle nut 10[, driving the threaded spindle 6,] is arranged rotatably in a further plate 11 of

the mold 1 for driving the threaded spindle 6. The spindle nut 10 is driven via a planetary gear mechanism 12 by an electric motor 13[,] . [the] The rotational speed and direction of rotation of [which] the electric motor 13 are prescribed by a control 14.

Further threaded screw drive assemblies 7a and 7b may be operatively connected to plates 2 and 2' as shown in the drawing for controlling the positions of plates 2 and 2'. Furthermore, a threaded screw driver 7c is also connected to plate 2 such that accurate replication may be achieved for large molded parts. The threaded screw drive assembly 7c includes a thread spindle 6c and a spindle nut 10c connected to plate 2. Accordingly, the plate 2 moves with the spindle nut 10c as the spindle nut traverses the threaded spindle 6c. In any of the threaded screw drive assemblies 7, 7a, 7b, 7c, either the threaded spindle or the spindle nut may be connected to the part to be moved, i.e., plate 2, plate 2', or mold insert 5.

For producing a molded part, the plate 2 moves toward the plate 2', so that the mold 1 is closed, with the mold insert [4] 5 entering the first negative form 4 of the plate 2. This position of the mold insert [4] 5 corresponds to the opening gap. A precisely defined amount of molding composition is then injected into the cavity 16[,] formed by the first negative form [3] 4 and the mold insert [4,] 5 via a hot-runner nozzle 15 arranged in the plate 2. In order that the molding composition does not cool down excessively as a result of thermal conduction, heating elements 17 for controlling the temperature of the plates 2, 2' are arranged in the plates 2, 2'. After the injection, [the] a gate 18 in the hot-runner nozzle 15 is closed by a gate needle 19. After that, the threaded spindle 6 is moved to the right by means of the spindle nut 10 to the extent that the mold insert [4] 5 is positioned at a defined distance - the compression gap - from the first negative form [3] 4 of the plate 2. With this reduction in volume of the cavity 16, the injected molding composition is subjected to pressure, so that the

molding composition completely fills the cavity 16. The positioning of the plate 2 in this case does not take place uniformly, but is controlled [over] by the control 14. The power consumption of the electric motor 13 is used as a [controlled] control variable. For this purpose, the power consumption is measured. With increasing internal mold pressure, the power consumption of the electric motor 13 increases. If the measured value is less than the prescribed value, the plate 2 is moved by 1 μm in the direction of the plate 2'. After that, the power consumption is measured again and compared with the setpoint value. As long as the measured value lies below the setpoint value, the plate 2 is moved step by step. If the measured value is greater than the setpoint value, the electric motor 13 is stopped. After a certain time, the plate 2 is moved again in the direction of the plate 2' and as this happens the power consumption is measured again. These steps are repeated until the molding composition has solidified. After solidifying of the molding composition, the mold 1 is opened at its mold parting plane between the plates 2, 2' and the finished molded part is ejected by [means of] an ejector 20.

In the Claims:

Please delete claims 1-16 and add new claims 17-32

17. (New) An apparatus for injection-compression molding of a molded part, comprising:

a mold including first and second plates having opposing end faces defining a mold parting plane for opening and closing the mold, wherein said opposing end faces have a

first negative form of the molded part to be produced and a gate through which a molding composition is introducible; and

a first threaded screw drive assembly connected to one of said first and second plates including a threaded screw drive, a gear mechanism connected to said threaded screw drive, and a controlled drive operatively connected to said threaded screw drive via said gear mechanism for positioning said one of said first and second plates.

18. (New) The apparatus of claim 17, wherein said first threaded screw drive assembly comprises a plurality of screw drive assemblies connected to said one of said first and second plates.

19. (New) The apparatus of claim 17, further comprising a second threaded drive screw assembly, wherein said first threaded screw drive assembly is operatively connected for positioning said first plate and said second threaded screw drive assembly is operatively connected for positioning said second plate.

20. (New) The apparatus of claim 17, wherein said threaded screw drive comprises a spindle nut connected to said one of said first and second plates.

21. (New) The apparatus of claim 17, wherein said threaded screw drive comprises a threaded spindle connected to said one of said first and second plates.

22. (New) The apparatus of claim 17, further comprising a mold insert having a second negative form of the molded part to be produced and arranged in said first and second plates and a second threaded screw drive assembly connected for positioning said mold insert.

23. (New) The apparatus of claim 17, further comprising a die arranged in one of said first and second plates having said first negative form, wherein said threaded screw drive is connected to said die.

24. (New) The apparatus of claim 17, further comprising heating elements arranged in said first and second plates.

25. (New) The apparatus of claim 17, wherein said gear mechanism is a planetary gear mechanism.

26. (New) The apparatus of claim 17, further comprising at least one ejector arranged in said threaded screw drive assembly.

27. (New) A method for injection-compression molding a molded part, comprising the steps of:

a. injecting a molding composition into a cavity of the mold defined at least partially by a plate having a negative form of the molded part to be produced;

b. moving the plate of the mold having a negative form of the molded part to be produced for compressing the molding composition via a threaded screw drive assembly; and

c. controlling the movement of the plate in said step b. by one of a movement program and in dependence on a process parameter.

28. (New) The method of claim 27, wherein said step c. comprises controlling the movement of the plate in dependence on a pressure present in the mold.

29. (New) The method of claim 27, wherein said step c. comprises controlling the movement of the plate in dependence on a power consumption of a motor driving the threaded screw drive assembly.

30. (New) The method of claim 27, wherein said step c. comprises controlling the movement of the plate in dependence on a force on the threaded screw drive.

31. (New) The method of claim 27, wherein said step b. comprises moving the plate via a step by step motion.

32. (New) The method of claim 31, wherein said step b. comprises moving the plate in a step by step motion comprising steps of less than 1 micrometer.

IN THE ABSTRACT:

Please amend the Abstract as follows:

[In known apparatus for injection-compression molding, the compressing pressure is applied by means of a hydraulically driven die which is moved against a stop. Wear and soiling of the stop cause inaccuracies in the replication of the molded part to be produced from the mold. With the apparatus and the method it is intended to ensure a high accuracy of replication of the molded parts to be produced.]

[The] An apparatus for injection-compression molding comprises a mold with plates [(2, 2')] which have the negative form of the molded part to be produced . [and, for positioning in relation to one another, are] The plates are connected to a threaded screw drive [(7)] which is driven via a gear mechanism [(12)] by a controlled drive [(13, 14)]. The positioning in this case takes place on the basis of a prescribed program or in dependence on at least one process parameter. The apparatus and the method make possible the production of molded parts, in particular plastic molded parts, with a high accuracy of replication.

Apparatus and method for injection-compression molding

Description

The invention concerns an apparatus and a method for injection-compression molding with a mold and a drive moving the mold. The apparatus and the method are used for producing molded parts, in particular plastic molded parts.

It is known to produce molded parts by means of injection-compression molding, in which a molding composition is injected into a mold and shaped under pressure. The mold generally comprises two plates which can be moved toward one another, a negative form of the molded part to be produced being arranged in each plate. During the closing of the mold, one plate is moved toward the other plate until an opening gap or initial gap is achieved. In this position, the plates enclose a cavity. An exactly metered amount of a molding composition is injected into this cavity, either via a conventional cold runner or via a hot-runner nozzle arranged in one plate. The molding composition is subsequently subjected to pressure. For this purpose, the plates are moved toward one another until a compression gap is achieved. In this position of the plates, the cavity enclosed by them corresponds to the later molded part. For achieving a high accuracy of replication of the negative form in the molded part produced, exact maintenance of the compression gap is a fundamental prerequisite.

On account of the high internal mold pressures of over 2000 bar, the movement of the plates is carried out hydraulically by means of pistons or toggle levers. A stop is used for positioning the plates in relation to one another to the size of the compression gap. The disadvantage of these apparatuses is that the stop is soiled and is subject to wear. As a result, the plates can no longer be positioned in relation to one another to the exact size of the compression gap. These small

deviations from the compression gap lead to inferior accuracies of replication and dimensional stabilities. Deviations of several hundredths of a millimeter are consequently customary. In many cases, in particular in the case of plastic molded parts, a better accuracy of replication would lead to an improvement of the products in which these plastic molded parts are used.

A further disadvantage is that the molding composition is injected in the hot state and is subsequently cooled in the mold. The cooling causes volume shrinkages of the molded part, which likewise lead to worsened accuracies of replication. Since both plates of the mold are positioned in relation to one another by means of the stop, there is no possibility at this time of being able to intervene in the molding process.

The stop for positioning the plates is generally not arranged in the vicinity of the cavity to be filled with molding composition. As a result, the shape and position tolerances of the mold likewise contribute to a worsening of the accuracy of replication. Finally, if there are changes, or after maintenance and repair work, extensive new settings and adjustments are necessary.

Also required for the movement of the plates is a hydraulic system with one or more pumps, lines, pressure accumulators and a multiplicity of valves with the associated control. In addition, pressure intensifiers are used to assist. If the pressure has to be applied very quickly on account of the geometry, the effort is particularly great, since often relatively large amounts of oil have to be transferred and the high-speed control of the valves is very complex. Added to this is the fact that every hydraulic system involves a certain amount of leakage.

The object of the invention is to provide an apparatus and a method for injection-compression molding which overcome the disadvantages of the prior art. With the method and the apparatus it is intended

to ensure a high accuracy of replication and reproducibility of the molded parts to be produced.

According to the invention, the object is achieved by the features of Patent Claims 1 and 11. Advantageous configurations are described in Claims 2 to 10 and 12 to 16.

The problem is solved by an apparatus for injection-compression molding which has a mold which comprises a plurality of plates and has at least one plate on which a threaded screw drive is arranged. Assigned to the threaded screw drive via a gear mechanism is a motor, which is in connection with a control.

With the method for injection-compression molding, the plates to be moved of the mold are controlled in such a way that they can be positioned in relation to one another continuously or discontinuously.

The controlled drive of the threaded screw drive allows the plates of the mold to be positioned exactly in relation to one another in every method step during the injection-compression molding. This provides the possibility of being able to intervene in the molding process at any time.

The great advantage is that the apparatus according to the invention does not require a stop for setting the compression gap, since the positioning of the plates of the mold to the compression gap is set by means of the control of the threaded screw drive. On account of the very exact positioning capability by means of threaded screw drives, the accuracy of replication is now determined principally by the negative forms machined in the plates. This makes it possible to achieve accuracies of replication of several thousandths of a millimeter. A further advantage of the positioning of the plates by means of a threaded screw drive is attributable to the fact that these systems are not exposed to soiling effects in the same way as mechanical stops. Consequently, a very

high degree of reproducibility is achieved over very long time periods. At the same time, previously necessary readjustments are no longer needed.

The method according to the invention has the advantage that the plates of the mold are no longer moved exclusively between end positions, but instead the injection-compression molding can now be freely configured. This is made possible by the movement of the plates as desired with a high accuracy, the positioning of the plates being able to be carried out in steps of down to < 1 µm and at different speeds. With the method, process sequences in the injection-compression molding which previously could not be carried out are possible. As a result, the process can be adapted optimally to the material and the geometry of the molded part to be produced.

The movement of the plates of the mold can in this case proceed on the basis of a prescribed program or be controlled in dependence on process parameters, the process parameters being adopted in the control as controlled variables.

In an advantageous configuration, the advancement for the movement of the plates is controlled pressure-dependently. This makes it possible to avoid inaccuracies of replication caused by shrinkage, since by this method the molding composition can be subjected to a defined pressure until curing. For this purpose, the internal mold pressure is measured and compared with a setpoint value. If the internal mold pressure falls below the setpoint value, the plate is moved by a defined distance in the direction of the other plate by means of the controlled drive, whereby the internal mold pressure rises again. The defined distances may in this case be steps of fractions of a millimeter down to steps of < 1 µm. After that, the internal mold pressure is measured again and compared with the setpoint value. By repeating this procedure an appropriate number of

times, a high internal mold pressure is ensured until curing of the molded part.

Since, with increasing internal mold pressure, the power consumption of the motor for driving the threaded screw drive also increases, in a particularly favorable form of the method according to the invention this power consumption is used as a controlled variable. Use of the power consumption as a process parameter also has the advantage that it can be easily sensed and can be accessed particularly well by the control as an electrical variable.

In a further configuration of the invention, a further process parameter serving as a controlled variable for the control is the force of the threaded screw drive. This process parameter is likewise proportional to the internal mold pressure and can be determined with relatively little effort.

The positioning of the plates for the actual compressing operation can begin both after the injection of the molding composition into the mold and during the injection of the molding composition. In the latter case, it is advantageous to begin the positioning only toward the end of the injection operation.

Change [sic] in the control are also possible without any problem. The connection of the threaded screw drive to the control allows various influencing factors to be taken into account in the positioning, so that readjustments are no longer needed and maintenance intervals can be extended. As a result, the apparatus according to the invention has a high level of productivity. Setting and adjustment after repair and maintenance work can be performed with the control in a simple way and in the shortest time.

Depending on the configuration, the plate to be moved is connected either to the spindle nut or to the threaded spindle of the threaded screw drive. In the first case, the threaded spindle is driven and the plates are positioned in relation to one another by

means of the translational movement of the spindle nut. In the other case, the fixedly arranged spindle nut is driven and the positioning of the plate takes place by the translational displacement of the threaded spindle.

In an advantageous configuration, one plate of the mold is connected to a threaded screw drive. It is also possible, however, to connect two plates to one threaded screw drive each. In this way, on the one hand the mold can be opened and closed with one threaded screw drive, while compression is carried out by means of the other threaded screw drive. On the other hand, the compression may also be performed by both threaded screw drives, by both plates being designed as compressing dies.

In a further advantageous configuration, the threaded screw drive is connected to a compressing die instead of to a plate. In this configuration, the compressing pressure is not applied by the plate, but by the compressing die. The compressing die may in this case also be one or more cores, which are arranged for producing certain geometries in the mold.

In another advantageous configuration, exchangeable mold inserts which have the negative form of the molded part to be produced are arranged in the plates. In this configuration, the threaded screw drive may be connected both to the mold insert and to the plate.

Dependent on the dimensions of the molded parts to be produced, it is advantageous to connect one plate to a plurality of threaded screw drives. This allows high accuracies of replication to be achieved even in the case of large molded parts.

A further advantageous configuration is to arrange a gear mechanism, preferably a planetary gear mechanism, between the motor and the threaded screw drive for achieving the necessary high axial forces for the injection-compression molding.

The invention allows numerous embodiments. To illustrate the basic principle, one of these is

described below. The associated figure shows a mold with a threaded screw drive, with a fixedly arranged spindle nut.

The apparatus for injection-compression molding comprises a mold 1, which has two plates 2, 2'. Machined in the plate 2 on the opposing end faces 3, 3' there is a negative form 4 of the molded part to be produced. Arranged in the plate 2' is a mold insert 5, in which there is machined a second negative form 4' on its side facing the plate 2. On its opposite side, the mold insert 5 is connected to a threaded spindle 6 of a threaded screw drive 7. The threaded spindle 6 is mounted in the plates 2' and 9 by means of antifriction guideways 8 in such a way that it is freely movable. A spindle nut 10, driving the threaded spindle 6, is arranged rotatably in a further plate 11 of the mold 1. The spindle nut 10 is driven via a planetary gear mechanism 12 by an electric motor 13, the rotational speed and direction of rotation of which are prescribed by a control 14. For producing a molded part, the plate 2 moves toward the plate 2', so that the mold 1 is closed, with the mold insert 4 entering the negative form of the plate 2. This position of the mold insert 4 corresponds to the opening gap. A precisely defined amount of molding composition is then injected into the cavity 16, formed by the negative form 3 and the mold insert 4, via a hot-runner nozzle 15 arranged in the plate 2. In order that the molding composition does not cool down excessively as a result of thermal conduction, heating elements 17 for controlling the temperature of the plates 2, 2' are arranged in the plates 2, 2'. After the injection, the gate 18 in the hot-runner nozzle 15 is closed by a gate needle 19. After that, the threaded spindle 6 is moved to the right by means of the spindle nut 10 to the extent that the mold insert 4 is positioned at a defined distance - the compression gap - from the negative form 3 of the plate 2. With this reduction in volume of the cavity 16, the injected molding composition is subjected to

pressure, so that the molding composition completely fills the cavity 16. The positioning of the plate in this case does not take place uniformly, but is controlled over [lacuna] by the control 14. The power consumption of the electric motor 13 is used as a controlled variable. For this purpose, the power consumption is measured. With increasing internal mold pressure, the power consumption of the electric motor 13 increases. If the measured value is less than the prescribed value, the plate 2 is moved by 1 µm in the direction of the plate 2'. After that, the power consumption is measured again and compared with the setpoint value. As long as the measured value lies below the setpoint value, the plate 2 is moved step by step. If the measured value is greater than the setpoint value, the electric motor 13 is stopped. After a certain time, the plate 2 is moved again in the direction of the plate 2' and as this happens the power consumption is measured again. These steps are repeated until the molding composition has solidified. After solidifying of the molding composition, the mold 1 is opened at its mold parting plane between the plates 2, 2' and the finished molded part is ejected by means of ejector 20.

Patent claims

1. Apparatus for injection-compression molding molded parts, in particular plastic molded parts, comprising a mold with at least two plates, the opposing end faces of which, as the mold parting plane for opening and closing the mold, have the negative form of the molded part to be produced, comprising means for introducing the molding composition and comprising means for moving at least one plate, characterized in that the plate (2, 2') is connected to a threaded screw drive (7), [lacuna] in that the threaded screw drive is driven via a gear mechanism (12) by a controlled drive (13, 14) in such a way that the plate (2, 2') can be positioned.

2. Apparatus for injection-compression molding according to Claim 1, characterized in that the plate (2, 2') is connected to a plurality of threaded screw drives (7).

3. Apparatus for injection-compression molding according to Claims 1 and 2, characterized in that a plurality of plates (2, 2') are connected to threaded screw drives (7).

4. Apparatus for injection-compression molding according to at least one of Claims 1 to 3, characterized in that the spindle nut (10) of the threaded screw drive (7) is connected to the plate (2, 2').

5. Apparatus for injection-compression molding according to at least one of Claims 1 to 3, characterized in that the threaded spindle (6) of the threaded screw drive (7) is connected to the plate (2, 2').

6. Apparatus for injection-compression molding according to at least one of Claims 1 to 5, characterized in that mold inserts (4), which have the negative form of the molded part to be produced, are arranged in the plates (2, 2') and in that at least one

threaded screw drive (7) is connected to at least one mold insert (4).

7. Apparatus for injection-compression molding according to Claims 1 to 5, characterized in that the threaded screw drive (7) is connected to cores or dies arranged in the plate (2, 2').

8. Apparatus for injection-compression molding according to at least one of Claims 1 to 7, characterized in that the plates (2, 2') have heating elements (17).

9. Apparatus for injection-compression molding according to at least one of Claims 1 to 7, characterized in that the gear mechanism is a planetary gear mechanism (12).

10. Apparatus for injection-compression molding according to at least one of Claims 1 to 9, characterized in that at least one ejector (20) is arranged in the threaded screw drive (7).

11. Method for injection-compression molding with a mold in which at least one of the plates, having the negative form of the molded part to be produced, is moved for opening and closing the mold and for compressing the molding composition injected into these plates, characterized in that the movement [sic] at least one plate is controlled on the basis of a prescribed program or in dependence on at least one process parameter.

12. Method according to Claim 11, characterized in that the positioning of the plate is controlled in dependence on the pressure present in the mold.

13. Method according to Claim 11, characterized in that the positioning of the plate is controlled in dependence on the power consumption of the motor driving the threaded screw drive.

14. Method according to Claim 11, characterized in that the positioning of the plate is controlled in dependence on the force of the threaded screw drive.

15. Method according to at least one of Claims 11 to 14, characterized in that the plate is positioned step by step.

16. Method according to Claim 15, characterized in that the plate is positioned in steps down to < 1 µm.

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Apparatus and method for injection-compression molding

Abstract

In known apparatuses for injection-compression molding, the compressing pressure is applied by means of a hydraulically driven die which is moved against a stop. Wear and soiling of the stop cause inaccuracies in the replication of the molded part to be produced from the mold. With the apparatus and the method it is intended to ensure a high accuracy of replication of the molded parts to be produced.

The apparatus comprises a mold with plates (2, 2') which have the negative form of the molded part to be produced and, for positioning in relation to one another, are connected to a threaded screw drive (7) which is driven via a gear mechanism (12) by a controlled drive (13, 14). The positioning in this case takes place on the basis of a prescribed program or in dependence on at least one process parameter.

The apparatus and the method make possible the production of molded parts, in particular plastic molded parts, with a high accuracy of replication.

(Figure 1)

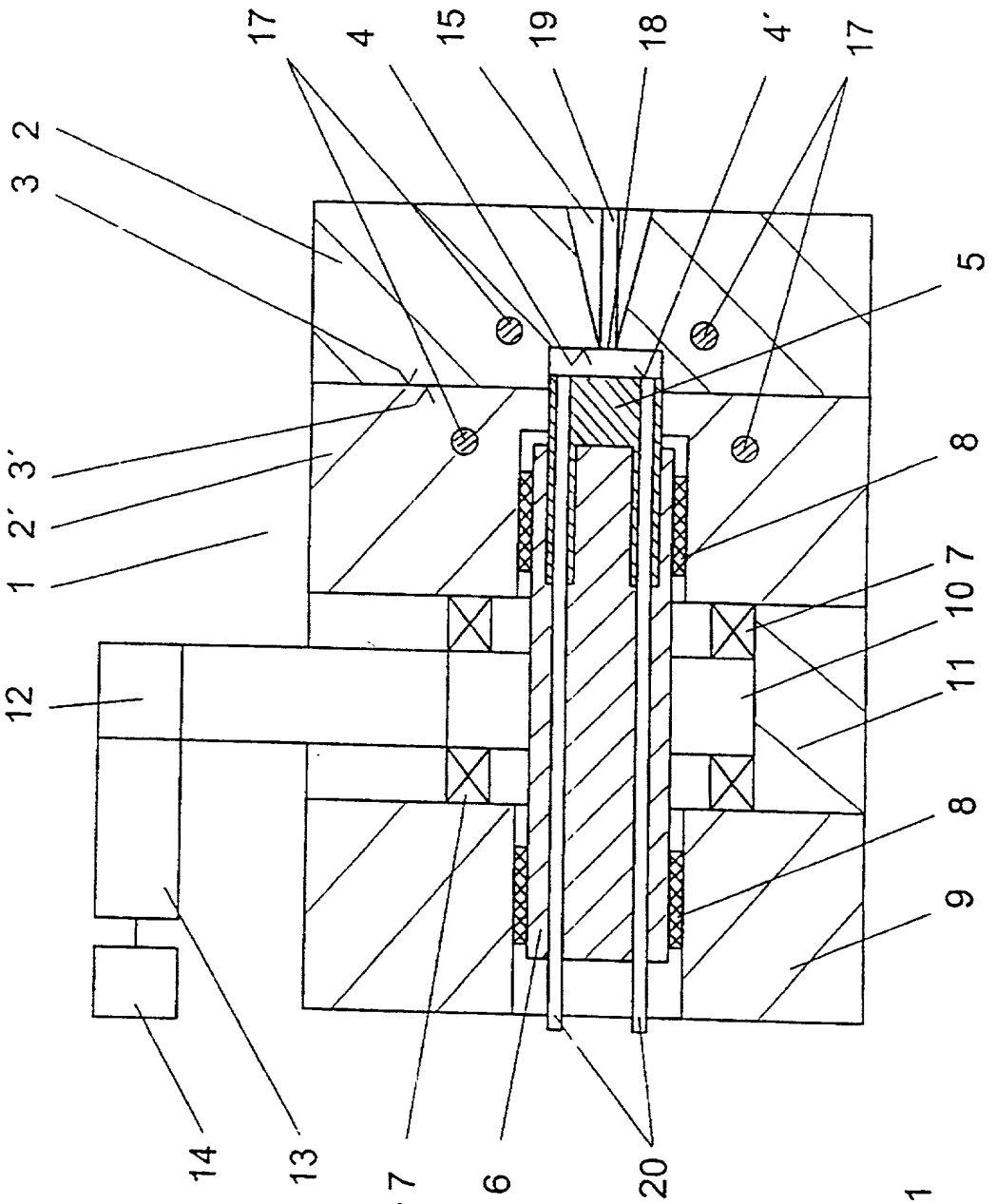

Fig. 1

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As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

DEVICE AND METHOD FOR INJECTION-COMPRESSION MOLDING

the specification of which (check only one item below)

[] is attached hereto

[] was filed as United States application

Serial No. _

on _

and was amended

on _ (if applicable).

[x] was filed as PCT international application

Number PCT/EP 99/06564

On 07 September 1999

And was amended under PCT Article 19

On _ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

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Country (if PCT, indicate "PCT")	Application Number	Date of Filing (day, month, year)	Priority Claimed Under 35 U.S.C. 119	
Germany	198 42 385.3	16 September 1998	[x] YES	[] NO
PCT	PCT/EP99/06564	07 September 1999	[x] YES	[] NO
			[] YES	[] NO
			[] YES	[] NO
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Combined Declaration for Patent Application and Power of Attorney (Continued) (Includes Reference to PCT International Applications)	Attorney's Docket No. 5029-30PUS

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

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